F ENT COOPERATION TRE

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 23 March 2001 (23.03.01)	
International application No. PCT/GB00/02549	**Applicant's or agent's file reference** DC286.IP00.015
International filing date (day/month/year) 10 July 2000 (10.07.00)	**Priority date** (day/month/year) 13 July 1999 (13.07.99)
Applicant BOUCHER, Neil, A. et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

05 February 2001 (05.02.01)

[] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Olivia TEFY
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* DC286.IP00.015

Box No. I TITLE OF INVENTION

Induced Absorption Filter (IAF)

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Coherent Optics Europe Limited
27-35 Ashville Way
Whetstone
Leicestershire
LE8 6NU
GB

☐ This person is also inventor.

Telephone No.
+ 44 (0)116 2867110

Facsimile No.
+ 44 (0)116 2867359

Teleprinter No.

State *(that is, country)* of nationality: GB

State *(that is, country)* of residence: GB

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Boucher, Neil A
Coherent Optics Europe Limited
27-35 Ashville Way
Whetstone
Leicestershire
LE8 6NU GB

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: GB

State *(that is, country)* of residence: GB

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Tillbrook, Christopher John
1 Mill Street
Warwick
CV34 4HB
GB

Telephone No.
+ 44 (0) 1926 490929

Facsimile No
+ 44 (0) 1926 419636

Teleprinter No

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Fischer, Dennis G
Coherent Auburn Group
Optics Division
2303 Lindbergh Street
Auburn
CA 95602, USA

This person is:
- [] applicant only
- [X] applicant and inventor
- [] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: USA

State *(that is, country)* of residence: USA

This person is applicant for the purposes of:
- [] all designated States
- [] all designated States except the United States of America
- [X] the United States of America only
- [] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [] applicant only
- [] applicant and inventor
- [] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [] all designated States
- [] all designated States except the United States of America
- [] the United States of America only
- [] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [] applicant only
- [] applicant and inventor
- [] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [] all designated States
- [] all designated States except the United States of America
- [] the United States of America only
- [] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [] applicant only
- [] applicant and inventor
- [] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [] all designated States
- [] all designated States except the United States of America
- [] the United States of America only
- [] the States indicated in the Supplemental Box

- [] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- [x] AP **ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- [x] EA **Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- [x] EP **European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- [x] OA **OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)*

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- [x] AE United Arab Emirates
- [x] AL Albania
- [x] AM Armenia
- [x] AT Austria
- [x] AU Australia
- [x] AZ Azerbaijan
- [x] BA Bosnia and Herzegovina
- [x] BB Barbados
- [x] BG Bulgaria
- [x] BR Brazil
- [x] BY Belarus
- [x] CA Canada
- [x] CH and LI Switzerland and Liechtenstein
- [x] CN China
- [x] CR Costa Rica
- [x] CU Cuba
- [x] CZ Czech Republic
- [x] DE Germany
- [x] DK Denmark
- [x] DM Dominica
- [x] EE Estonia
- [x] ES Spain
- [x] FI Finland
- [x] GB United Kingdom
- [x] GD Grenada
- [x] GE Georgia
- [x] GH Ghana
- [x] GM Gambia
- [x] HR Croatia
- [x] HU Hungary
- [x] ID Indonesia
- [x] IL Israel
- [x] IN India
- [x] IS Iceland
- [x] JP Japan
- [x] KE Kenya
- [x] KG Kyrgyzstan
- [x] KP Democratic People's Republic of Korea
- [x] KR Republic of Korea
- [x] KZ Kazakhstan
- [x] LC Saint Lucia
- [x] LK Sri Lanka
- [x] LR Liberia
- [x] LS Lesotho
- [x] LT Lithuania
- [x] LU Luxembourg
- [x] LV Latvia
- [x] MA Morocco
- [x] MD Republic of Moldova
- [x] MG Madagascar
- [x] MK The former Yugoslav Republic of Macedonia
- [x] MN Mongolia
- [x] MW Malawi
- [x] MX Mexico
- [x] NO Norway
- [x] NZ New Zealand
- [x] PL Poland
- [x] PT Portugal
- [x] RO Romania
- [x] RU Russian Federation
- [x] SD Sudan
- [x] SE Sweden
- [x] SG Singapore
- [x] SI Slovenia
- [x] SK Slovakia
- [x] SL Sierra Leone
- [x] TJ Tajikistan
- [x] TM Turkmenistan
- [x] TR Turkey
- [x] TT Trinidad and Tobago
- [x] TZ United Republic of Tanzania
- [x] UA Ukraine
- [x] UG Uganda
- [x] US United States of America
- [x] UZ Uzbekistan
- [x] VN Viet Nam
- [x] YU Yugoslavia
- [x] ZA South Africa
- [x] ZW Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- []
- []

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 13/07/1999 13 July 1999	GB 9916339.6	GB		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*: ISA/

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*: Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request	: 4
description (excluding sequence listing part)	: 19
claims	: 9
abstract	: 1
drawings	: 7
sequence listing part of description	:
Total number of sheets	: 40

This international application is **accompanied by** the item(s) marked below:

1. ☐ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☐ other *(specify)*:

Figure of the drawings which should accompany the abstract: 3

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request)

TILLBROOK, Christopher John (Agent)

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

TILLBROOK, Christopher, John
1 Mill Street
Warwick CV34 4HB
GRANDE BRETAGNE

NOTIFICATION OF RECEIPT OF DEMAND BY COMPETENT INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rules 59.3(e) and 61.1(b), first sentence and Administrative Instructions, Section 601(a))

Date of mailing *(day/month/year)*	08.03.01
Applicant's or agent's file reference: 00363.IP00.015	IMPORTANT NOTIFICATION

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB 00/02549	10/07/2000	13/07/1999

Applicant

COHERENT OPTICS EUROPE LIMITED et al.

1. The applicant is hereby **notified** that this International Preliminary Examining Authority considers the following date as the date of receipt of the demand for international preliminary examination of the international application:

05/02/2001

2. This date of receipt is:

- [X] the actual date of receipt of the demand by this Authority (Rule 61.1(b)).
- [] the actual date of receipt of the demand on behalf of this Authority (Rule 59.3(e)).
- [] the date on which this Authority has, in response to the invitation to correct defects in the demand (Form PCT/IPEA/404), received the required corrections.

3. [] **ATTENTION:** That date of receipt is **AFTER** the expiration of 19 months from the priority date. Consequently, the election(s) made in the demand does (do) not have the effect of postponing the entry into the national phase until 30 months from the priority date (or later in some Offices) (Article 39(1)). Therefore, the acts for entry into the national phase must be performed within 20 months from the priority date (or later in some Offices) (Article 22). For details, see the *PCT Applicant's Guide*, Volume II.

[] *(If applicable)* This notification confirms the information given by telephone, facsimile transmission or in person on: _____

4. Only where paragraph 3 applies, a copy of this notification has been sent to the International Bureau.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	MOSER A R Tel. (+49-89) 2399-8240

EUROPÄISCHES PATENTAMT - EUROPEAN PATENT OFFICE - OFFICE EUROPÉEN DES BREVETS

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
TILLBROOK, Christopher, John
1 Mill Street
Warwick CV34 4HB
GRANDE BRETAGNE

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	12.04.2001
Applicant's or agent's file reference: 00363.IP00.015	**REPLY DUE** **within 3 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02549	10/07/2000	13/07/1999

International Patent Classification (IPC) or both national classification and IPC
G02B5/28

Applicant
COHERENT OPTICS EUROPE LIMITED et al.

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☒	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 13/11/2001.

Name and mailing address of the international preliminary examining authority:
European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner
Denise, C

Formalities officer (incl. extension of time limits)
Atienza Vivancos, B
Telephone No. +49 89 2399 7891

WRITTEN OPINION

International application No. PCT/GB00/02549

I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, pages:

1-19 as originally filed

Claims, No.:

1-24 as originally filed

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

WRITTEN OPINION

International application No. PCT/GB00/02549

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

☐ the entire international application,

☒ claims Nos. 3-6, 15,

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A written opinion cannot be drawn due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation (Form PCT/IPEA/405) to restrict or pay additional fees, the applicant has:

☐ restricted the claims.

☐ paid additional fees.

WRITTEN OPINION

International application No. PCT/GB00/02549

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with for the following reasons and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees:
see separate sheet

3. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this opinion:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1, 2
Inventive step (IS)	Claims	1, 2, 7-14, 17, 18, 20-22, 24
Industrial applicability (IA)	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

WRITTEN OPINION
SEPARATE SHEET

International application No. PCT/GB00/02549

SECTION VIII

The following remarks concern lack of clarity (Article 6 PCT) in claims 1, 3, 6-14, 16-23

1 Clarity

1.1 Claim 1

The expression "opaque, reflective layer" is not clear, because "opaque" usually means "which absorbs the radiation for a given wavelength range". In this respect, without knowing precisely the wavelength range for which the optical filter is supposed to work, it is not clear how a metallic layer can, at the same time, be opaque and reflective.

1.2 Claim 3

For the sake of clarity, the following expression in claim 3 "varies in thickness spatially" has been interpreted as "varies substantially in thickness spatially". Without this clarification, because any layer, at least at an atomic level, varies in thickness spatially, it appears that the subject matter of claim 3 is identical to that one of claim 1.

1.3 Claim 6

It appears that an essential feature is missing in claim 6, i.e. the feature responsible for the tunability (in other words, the feature which would allow a user to tune a radiation over a specific wavelength). In its present form, claim 6 recites the subject matter of claims 1 and 4 or claims 1 and 5 and is therefore redundant.

1.4 Claims 7-12 and 15

1.4.1 The parameter x is not defined in claim 7. By considering that the parameter x can be equal to any integer and because in claim 7 it is not clear how the optical filter is rendered tunable, it follows that the subject matter of claim 7 is identical to that one of claim 1 (when n=0 for example).

1.4.2 In claims 7-12 and claim 15, it is also not clear how the filter is rendered tunable.

1.4.3 Furthermore, claim 7 tries to define the optical thickness of the spacer layer with respect to a quarter-wave (a quarter wavelength presumably). Because no wavelength is defined, it follows that the optical thickness of the spacer layer is unknown. This is also valid for claims 8-11 and 12.
In addition, it appears that the passage of claim 7 from line 11 to line 14 recites only a well known property of an optical resonator comprising a spacer layer (like, for instance, a Fabry Pérot resonator).

1.4.4 Remarks similar to those ones made above concerning claim 7 can also be made for claims 8 (section VIII, points 1.4.1 and 1.4.3) and 9 (section VIII, point 1.4.3).
Furthermore, the three last lines of claim 9 refer rather to a well known effect of optical resonator and have not been considered as reciting a limiting feature of the defined optical filter.

1.4.5 Although claims 10, 11 and 12 are drafted as independent claim, it appears that they actually depend on claim 1, because the first layer coming right after M (on the right) can always be considered as being a spacer layer. This renders the scope for which protection is sough unclear.
In addition, it is not clear in claim 12 wether x has a value between 4 and 1000 or a value equal to 100.

1.4.6 Claims 16, 19 and 23
These claims are not allowable under Rule 6.2 (a) PCT (see also the PCT Gazette, section IV, III.4.10)

1.4.7 Claims 14, 17, 18, 20, 21 and 22
It seems that these claims fail to recite all the essential features of the object for which protection is sough. In particular, claims 14, 17, 18, 20 and 21 all recite an induced absorption filter, without indicating the structural features of such a filter.
Either such a filter is not obvious for a skilled person, which, in this case,

means that claims 14, 17, 18, 20 and 21 are obscure. Either such a filter is well known (which appears to be the case, see D3), which, in this case, means that the subject matter of said claims is not novel or does not involve an inventive step (see section V).

Furthermore, claim 22 is obscure because it refers to a fixed or variable wavelength Induced Absorption Filter as claimed in any preceding claims, but it is not clear to which claims it refers.

1.4.8 In addition, it appears that claims 3-6 and 15 are not supported by the description.
Indeed, the description (see page 15, lines 8-11) refers to Patent Applications. The description does not actually describe the technology involved, and therefore does not fulfill the requirements of Article 5 PCT.

1.5 In the description, the distinction between "Rule 1 and Rule 2" (see pages 8 and 9 and "specific embodiments" (see page 16) is not understood.

SECTION III

In the light of the objection made section VIII, point 1.4.8, an examination of claims 3-6 and 15 pursuant to Articles 33 (2) and 33 (3) PCT could not be carried out.

SECTION IV

It appears that, in the light of the remarks made at section VIII, the common concept between claims 1, 15 and 24 is a well known optical filter having an absorbent layer or substrate (see for example D2, abstract and Fig.5).

It follows that there is a lack of unity (Rule 13.1 PCT) between claims 1, 15 and 24.

SECTION V

1 Reference is made to the following documents :

D1 : US-A-4 335 935 (POHLACK HUBERT) 22 June 1982 (1982-06-22)
D2 : EP-A-0 921 419 (COMMISSARIAT ENERGIE ATOMIQUE) 9 June 1999 (1999-06-09) cited in the application
D3 : LEEB W R: 'CO2 Laser Line Selection with Metal Film Reflector' ARCHIV FÜR ELEKTRONIK UND ÜBERTRAGUNGSTECHNIK, vol. 32, no. 5/6, 30 June 1978 (1978-06-30), pages 186-190, XP000960847

2 In the light of what has already been discussed in section VIII, the following remarks concerning lack of novelty (Article 33 (2) PCT) in claims 1, 2 and lack of inventive step in claims 1-2, 7-14, 17-18, 20-22 and 24 (Article 33 (3) PCT) are to be made.

2.1 D1 discloses an absorption device (which can be considered as an optical filter because it can be rendered absorbent in a given spectral range) comprising :

- a dielectric stack of alternating high and low refractive index layers,
- a dielectric spacer layer in juxtaposition with
- an opaque, reflective metallic layer,
- the filter having a resonant wavelength, at which wavelength incident radiation is channelled into, and absorbed by, the metallic layer

See column 3, lines 10-17, wherein the non absorbing layer (3) is considered as a spacer layer, and see in particular lines 16-17 which disclose the functional feature corresponding to the three last lines of claim 1. Furthermore, because the

metallic layer is an absorbing layer (see column 3, line 11), it can be considered as an opaque layer (for the wavelength which are absorbed).

Therefore, D1 discloses an optical filter comprising all the structural and functional features of the optical filter defined in claim 1.

2.2 D2 discloses structures made of a substrate, an absorbing layer and low reflectivity layer (AR) (see column 1, lines 43-44), wherein the absorbing layer can be made of "black chromium" (see column 2, lines 11-12) and the low reflective layer of alternating high and low refractive index layers (see column 2, lines 30-33).
Furthermore, those structures work as "light trap" (see column 1, lines 26-30). Therefore, it is quite obvious that also for these structures, the filter has a resonant wavelength (due to the alternating dielectric layers) and that the resonant wavelength is absorbed by the metallic absorbing layer (because the purpose of these structures is to reduce as much as possible the reflected light, thus to provide a metallic layer absorbing as much as possible radiation, and in particular the resonant wavelength radiation which contains a lot of energy).

Therefore, D2 discloses also all he structural and functional features recited in claim 1.

In addition, in case the applicant is of the opinion that the features of claim 1 are not explicitly disclosed by D2, the following ca also be said : a skilled person, confronted with the problem of providing a good absorbing filter, would have no difficulty at all, with the teaching of D2, to provide such a filter by an obvious combination of features disclosed in D2, and would arrive at the subject matter of claim 1 without the need of an inventive step.

2.3 Claim 2 : obvious configuration (see D2, Fig.1 and see point 2.1).

Claims 7 and 8 : if n=0, the subject matter of claims 7 and 8 concern only an arbitrary example of optical filter having a substrate, a metallic layer and alternating high and low refractive index layers. The choice of the number of such

layers is not considered to be inventive, because no specific is expected from it.

Claim 9 : In the light of the discussion made at section VIII, it appears that the subject matter of claim 9 is also anticipated by documents D1 and D2. A similar conclusion can be drawn about claims 10 and 12.

Claim 11 : The choice of a spacer layer being formed of three high refractive index layers is not considered to involve an inventive step, because it does not bring any specific effect.

Claim 13 concerns only an obvious functional feature, i.e. the optimisation of the profile of a filter curve.

Claim 14 : (see also section VIII). Such a filter (an IAF) is well known in the prior art (see D3).

Claims 17, 20 and 22 : see D3, wherein a IAF is used in a laser (see abstract).

Claims 18 and 21 : the use of two IAF in a laser is only the addition of two non inventive device and is also not considered to involve an inventive step.

Claim 24 : recites only an obvious specific use of a IAF in a laser.

SECTION VII

1 The application does not meet the requirements of **Rule 5.1. (a) (ii) PCT** (citation of relevant prior art documents e.g. D1, D2 and D3).

2 The application does not meet the requirements of **Rule 6.3 (b) (i) and (ii) PCT** (two part form of the independent claim(s)).

3 The application does not meet the requirements of **Rule 6.2 (b) PCT** (reference

numerals in all the claims).

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

To:
Tillbrook, Christopher John
1 Mill Street,
CV34 4HB WARWICK
UNITED KINGDOM

Applicant's or agent's file reference DC286.IP00.015	Date of mailing (day/month/year) 08/12/2000
International application No. PCT/GB 00/02549	FOR FURTHER ACTION See paragraphs 1 and 4 below
Applicant COHERENT OPTICS EUROPE LIMITED et al.	International filing date (day/month/year) 10/07/2000

1. [X] The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. [] The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

[] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Marie-Françoise Provot

Form PCT/ISA/220 (July 1998)

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

\SDOCID: <XSISA220NOENP4_1_>

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

(i) the claim is unchanged;

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international appplication is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

NSDOCID: <X9ISA220NOENP4_I_>

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
DC286.IP00.015		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/02549	10/07/2000	13/07/1999
Applicant		
COHERENT OPTICS EUROPE LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[] contained in the international application in written form.

[] filed together with the international application in computer readable form.

[] furnished subsequently to this Authority in written form.

[] furnished subsequently to this Authority in computer readble form.

[] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [] **Certain claims were found unsearchable** (See Box I).

3. [] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

[X] the text is approved as submitted by the applicant.

[] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

[X] the text is approved as submitted by the applicant.

[] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

[X] as suggested by the applicant.

[] None of the figures.

[] because the applicant failed to suggest a figure.

[] because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02549

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B5/28 G02B5/08 H01S3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02B H01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LEEB W R: "CO2 Laser Line Selection with Metal Film Reflector" ARCHIV FÜR ELEKTRONIK UND ÜBERTRAGUNGSTECHNIK, vol. 32, no. 5/6, 30 June 1978 (1978-06-30), pages 186-190, XP000960847 the whole document	14,17, 18,20, 21,24 D3
X	WO 98 12583 A (SECR DEFENCE ;SIMPSON JOHN (GB)) 26 March 1998 (1998-03-26)	1,2,14
Y	page 3 -page 4, paragraph 1 page 12, paragraph 4 -page 13, paragraph 1	3-6,13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2000	08/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mollenhauer, R

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02549

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 921 419 A (COMMISSARIAT ENERGIE ATOMIQUE) 9 June 1999 (1999-06-09) cited in the application	14 D2
A	column 4, line 23 - line 41	1,2
Y	TONG F M ET AL: "DESIGN AND SIMULATION OF PERMISSIBLE TOLERANCE DURING FABRICATION OF INFRARED-INDUCED TRANSMISSION FILTERS" OPTICAL ENGINEERING,US,SOC. OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS. BELLINGHAM, vol. 36, no. 2, 1 February 1997 (1997-02-01), pages 549-557, XP000686880 ISSN: 0091-3286	13
A	the whole document	1,2
X	US 4 335 935 A (POHLACK HUBERT) 22 June 1982 (1982-06-22)	14 D1
A	the whole document	1,2
X	US 4 622 174 A (GUPTA AMITAVE ET AL) 11 November 1986 (1986-11-11)	14
A	column 1, line 47 - line 62	1
A	US 5 850 309 A (ABOSHI JUNJI ET AL) 15 December 1998 (1998-12-15) column 2, line 46 - line 59 column 3, line 17 - line 43	1,2
A	MANQING TAN ET AL: "REFLECTION FILTER WITH HIGH REFLECTIVITY AND NARROW BANDWIDTH" APPLIED OPTICS,US,OPTICAL SOCIETY OF AMERICA,WASHINGTON, vol. 36, no. 4, 1 February 1997 (1997-02-01), pages 827-830, XP000685213 ISSN: 0003-6935 the whole document	1,2
A	US 4 519 708 A (PERLMUTTER MICHAEL S ET AL) 28 May 1985 (1985-05-28) column 8, line 19 - line 56	1
Y	GB 2 321 256 A (COHERENT OPTICS) 22 July 1998 (1998-07-22) cited in the application the whole document	3-6

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3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02549

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	POHLACK H: "Grundlagen und Anwendungen der induzierten Resonanzabsorption (Teil 1)" FEINGERÄTETECHNIK, vol. 32, no. 7, 1983, pages 321-326, XP000965353 Berlin page 324 -page 326 ---	1
A	US 4 009 453 A (MAHLEIN HANS) 22 February 1977 (1977-02-22) column 2, line 57 -column 3, line 10 ---	17-24
A	US 3 582 815 A (SIEBERT LARRY D) 1 June 1971 (1971-06-01) abstract ---	17-24
T	US 4 723 248 A (HARTER DONALD J ET AL) 2 February 1988 (1988-02-02) column 2, line 57 -column 3, line 3 ---	14,17, 18,20
T	US 3 975 694 A (MELAMED NATHAN T ET AL) 17 August 1976 (1976-08-17) column 1, line 58 -column 2, line 16 -----	14,17, 18,20

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02549

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9812583 A	26-03-1998	EP 0927371 A	07-07-1999
EP 0921419 A	09-06-1999	FR 2772141 A	11-06-1999
		JP 11231128 A	27-08-1999
US 4335935 A	22-06-1982	DD 146224 A	28-01-1981
		DE 3014911 A	06-11-1980
		FR 2464486 A	06-03-1981
US 4622174 A	11-11-1986	NONE	
US 5850309 A	15-12-1998	JP 9265005 A	07-10-1997
		JP 10160915 A	19-06-1998
US 4519708 A	28-05-1985	AU 572392 B	05-05-1988
		AU 5703086 A	11-09-1986
		AU 553685 B	24-07-1986
		AU 8301882 A	25-11-1982
		BE 893254 A	16-09-1982
		CA 1201190 A	25-02-1986
		CH 661154 A	30-06-1987
		DE 3217916 A	09-12-1982
		DK 226782 A,B,	07-01-1983
		FR 2506451 A	26-11-1982
		GB 2099178 A,B	01-12-1982
		IT 1147973 B	26-11-1986
		JP 1017275 B	29-03-1989
		JP 1611100 C	15-07-1991
		JP 57210681 A	24-12-1982
		NL 8202002 A,B,	16-12-1982
		NO 821656 A,B,	26-01-1983
		SE 451889 B	02-11-1987
		SE 8203079 A	21-11-1982
		US 4627732 A	09-12-1986
GB 2321256 A	22-07-1998	EP 0854201 A	22-07-1998
		US 5993904 A	30-11-1999
US 4009453 A	22-02-1977	DE 2449312 A	22-04-1976
		BE 834580 A	16-02-1976
		FR 2288319 A	14-05-1976
		GB 1529813 A	25-10-1978
		IT 1043264 B	20-02-1980
		NL 7512111 A	21-04-1976
US 3582815 A	01-06-1971	BE 724872 A	04-06-1969
		BE 725410 A	13-06-1969
		DE 1814039 A	07-08-1969
		FR 1554864 A	24-01-1969
		FR 1594500 A	01-06-1970
		NL 6817061 A	17-06-1969
		NL 6817730 A	13-06-1969
US 4723248 A	02-02-1988	US 4633475 A	30-12-1986
US 3975694 A	17-08-1976	NONE	

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

TILLBROOK, Christopher, John
1 Mill Street
Warwick CV34 4HB
GRANDE BRETAGNE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	14.08.2001
Applicant's or agent's file reference: 00363.IP00.015	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02549	10/07/2000	13/07/1999

Applicant: COHERENT OPTICS EUROPE LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Zeiselmair, S Tel.+49 89 2399-2151

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
00363.IP00.015		

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02549	10/07/2000	13/07/1999

International Patent Classification (IPC) or national classification and IPC
G02B5/28

Applicant
COHERENT OPTICS EUROPE LIMITED et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 12 sheets, including this cover sheet.

 ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

 - I ☒ Basis of the report
 - II ☐ Priority
 - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☒ Lack of unity of invention
 - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
 - VI ☐ Certain documents cited
 - VII ☒ Certain defects in the international application
 - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05/02/2001	14.08.2001

Name and mailing address of the international preliminary examining authority:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Denise, C Telephone No. +49 89 2399 2452

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02549

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-19 as originally filed

Claims, No.:

1-24 as originally filed

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02549

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 3-6, 15.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02549

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1, 2
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1, 2, 7-14, 17, 18, 20-22, 24
Industrial applicability (IA)	Yes:	Claims	1-24
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02549

see separate sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT - SEPARATE SHEET

International application No. PCT/GB00/02549

SECTION VIII

The following remarks concern lack of clarity (Article 6 PCT) in claims 1, 3, 6-14, 16-23

1 Clarity

1.1 Claim 1

The expression "opaque, reflective layer" is not clear, because "opaque" usually means "which absorbs the radiation for a given wavelength range". In this respect, without knowing precisely the wavelength range for which the optical filter is supposed to work, it is not clear how a metallic layer can, at the same time, be opaque and reflective.

1.2 Claim 3

For the sake of clarity, the following expression in claim 3 "varies in thickness spatially" has been interpreted as "varies substantially in thickness spatially". Without this clarification, because any layer, at least at an atomic level, varies in thickness spatially, it appears that the subject matter of claim 3 is identical to that one of claim 1.

1.3 Claim 6

It appears that an essential feature is missing in claim 6, i.e. the feature responsible for the tunability (in other words, the feature which would allow a user to tune a radiation over a specific wavelength). In its present form, claim 6 recites the subject matter of claims 1 and 4 or claims 1 and 5 and is therefore redundant.

1.4 Claims 7-12 and 15

1.4.1 The parameter x is not defined in claim 7. By considering that the parameter x can be equal to any integer and because in claim 7 it is not clear how the optical filter is rendered tunable, it follows that the subject matter of claim 7 is identical to that one of claim 1 (when n=0 for example).

1.4.2 In claims 7-12 and claim 15, it is also not clear how the filter is rendered tunable.

1.4.3 Furthermore, claim 7 tries to define the optical thickness of the spacer layer with respect to a quarter-wave (a quarter wavelength presumably). Because no wavelength is defined, it follows that the optical thickness of the spacer layer is unknown. This is also valid for claims 8-11 and 12.
In addition, it appears that the passage of claim 7 from line 11 to line 14 recites only a well known property of an optical resonator comprising a spacer layer (like, for instance, a Fabry Pérot resonator).

1.4.4 Remarks similar to those ones made above concerning claim 7 can also be made for claims 8 (section VIII, points 1.4.1 and 1.4.3) and 9 (section VIII, point 1.4.3).
Furthermore, the three last lines of claim 9 refer rather to a well known effect of optical resonator and have not been considered as reciting a limiting feature of the defined optical filter.

1.4.5 Although claims 10, 11 and 12 are drafted as independent claim, it appears that they actually depend on claim 1, because the first layer coming right after M (on the right) can always be considered as being a spacer layer. This renders the scope for which protection is sough unclear.
In addition, it is not clear in claim 12 wether x has a value between 4 and 1000 or a value equal to 100.

1.4.6 Claims 16, 19 and 23
These claims are not allowable under Rule 6.2 (a) PCT (see also the PCT Gazette, section IV, III.4.10)

1.4.7 Claims 14, 17, 18, 20, 21 and 22
It seems that these claims fail to recite all the essential features of the object for which protection is sough. In particular, claims 14, 17, 18, 20 and 21 all recite an induced absorption filter, without indicating the structural features of such a filter.
Either such a filter is not obvious for a skilled person, which, in this case,

means that claims 14, 17, 18, 20 and 21 are obscure. Either such a filter is well known (which appears to be the case, see D3), which, in this case, means that the subject matter of said claims is not novel or does not involve an inventive step (see section V).

Furthermore, claim 22 is obscure because it refers to a fixed or variable wavelength Induced Absorption Filter as claimed in any preceding claims, but it is not clear to which claims it refers.

1.4.8 In addition, it appears that claims 3-6 and 15 are not supported by the description.
Indeed, the description (see page 15, lines 8-11) refers to Patent Applications. The description does not actually describe the technology involved, and therefore does not fulfill the requirements of Article 5 PCT.

1.5 In the description, the distinction between "Rule 1 and Rule 2" (see pages 8 and 9 and "specific embodiments" (see page 16) is not understood.

SECTION III

In the light of the objection made section VIII, point 1.4.8, an examination of claims 3-6 and 15 pursuant to Articles 33 (2) and 33 (3) PCT could not be carried out.

SECTION IV

It appears that, in the light of the remarks made at section VIII, the common concept between claims 1, 15 and 24 is a well known optical filter having an absorbent layer or substrate (see for example D2, abstract and Fig.5).

It follows that there is a lack of unity (Rule 13.1 PCT) between claims 1, 15 and 24.

SECTION V

1 Reference is made to the following documents :

D1 : US-A-4 335 935 (POHLACK HUBERT) 22 June 1982 (1982-06-22)
D2 : EP-A-0 921 419 (COMMISSARIAT ENERGIE ATOMIQUE) 9 June 1999 (1999-06-09) cited in the application
D3 : LEEB W R: 'CO2 Laser Line Selection with Metal Film Reflector' ARCHIV FÜR ELEKTRONIK UND ÜBERTRAGUNGSTECHNIK, vol. 32, no. 5/6, 30 June 1978 (1978-06-30), pages 186-190, XP000960847

2 In the light of what has already been discussed in section VIII, the following remarks concerning lack of novelty (Article 33 (2) PCT) in claims 1, 2 and lack of inventive step in claims 1-2, 7-14, 17-18, 20-22 and 24 (Article 33 (3) PCT) are to be made.

2.1 D1 discloses an absorption device (which can be considered as an optical filter because it can be rendered absorbent in a given spectral range) comprising :

- a dielectric stack of alternating high and low refractive index layers,
- a dielectric spacer layer in juxtaposition with
- an opaque, reflective metallic layer,
- the filter having a resonant wavelength, at which wavelength incident radiation is channelled into, and absorbed by, the metallic layer

See column 3, lines 10-17, wherein the non absorbing layer (3) is considered as a spacer layer, and see in particular lines 16-17 which disclose the functional feature corresponding to the three last lines of claim 1. Furthermore, because the

ENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
DC286.IP00.015		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02549	10/07/2000	13/07/1999
Applicant		
COHERENT OPTICS EUROPE LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

 a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

 [] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

 b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

 [] contained in the international application in written form.

 [] filed together with the international application in computer readable form.

 [] furnished subsequently to this Authority in written form.

 [] furnished subsequently to this Authority in computer readble form.

 [] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

 [] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [] **Certain claims were found unsearchable** (See Box I).

3. [] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

 [X] the text is approved as submitted by the applicant.

 [] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

 [X] the text is approved as submitted by the applicant.

 [] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

 [X] as suggested by the applicant.

 [] because the applicant failed to suggest a figure.

 [] because this figure better characterizes the invention.

 [] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
P[redacted]B 00/02549

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B5/28 G02B5/08 H01S3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02B H01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LEEB W R: "CO2 Laser Line Selection with Metal Film Reflector" ARCHIV FÜR ELEKTRONIK UND ÜBERTRAGUNGSTECHNIK, vol. 32, no. 5/6, 30 June 1978 (1978-06-30), pages 186-190, XP000960847 the whole document ---	14,17, 18,20, 21,24
X	WO 98 12583 A (SECR DEFENCE ;SIMPSON JOHN (GB)) 26 March 1998 (1998-03-26)	1,2,14
Y	page 3 -page 4, paragraph 1 page 12, paragraph 4 -page 13, paragraph 1 --- -/--	3-6,13

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2000	08/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Mollenhauer, R

3

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 921 419 A (COMMISSARIAT ENERGIE ATOMIQUE) 9 June 1999 (1999-06-09) cited in the application	14
A	column 4, line 23 - line 41	1,2
Y	TONG F M ET AL: "DESIGN AND SIMULATION OF PERMISSIBLE TOLERANCE DURING FABRICATION OF INFRARED-INDUCED TRANSMISSION FILTERS" OPTICAL ENGINEERING,US,SOC. OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS. BELLINGHAM, vol. 36, no. 2, 1 February 1997 (1997-02-01), pages 549-557, XP000686880 ISSN: 0091-3286	13
A	the whole document	1,2
X	US 4 335 935 A (POHLACK HUBERT) 22 June 1982 (1982-06-22)	14
A	the whole document	1,2
X	US 4 622 174 A (GUPTA AMITAVE ET AL) 11 November 1986 (1986-11-11)	14
A	column 1, line 47 - line 62	1
A	US 5 850 309 A (ABOSHI JUNJI ET AL) 15 December 1998 (1998-12-15) column 2, line 46 - line 59 column 3, line 17 - line 43	1,2
A	MANQING TAN ET AL: "REFLECTION FILTER WITH HIGH REFLECTIVITY AND NARROW BANDWIDTH" APPLIED OPTICS,US,OPTICAL SOCIETY OF AMERICA,WASHINGTON, vol. 36, no. 4, 1 February 1997 (1997-02-01), pages 827-830, XP000685213 ISSN: 0003-6935 the whole document	1,2
A	US 4 519 708 A (PERLMUTTER MICHAEL S ET AL) 28 May 1985 (1985-05-28) column 8, line 19 - line 56	1
Y	GB 2 321 256 A (COHERENT OPTICS) 22 July 1998 (1998-07-22) cited in the application the whole document	3-6

-/--

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	POHLACK H: "Grundlagen und Anwendungen der induzierten Resonanzabsorption (Teil 1)" FEINGERÄTETECHNIK, vol. 32, no. 7, 1983, pages 321-326, XP000965353 Berlin page 324 -page 326 ---	1
A	US 4 009 453 A (MAHLEIN HANS) 22 February 1977 (1977-02-22) column 2, line 57 -column 3, line 10 ---	17-24
A	US 3 582 815 A (SIEBERT LARRY D) 1 June 1971 (1971-06-01) abstract ---	17-24
T	US 4 723 248 A (HARTER DONALD J ET AL) 2 February 1988 (1988-02-02) column 2, line 57 -column 3, line 3 ---	14,17, 18,20
T	US 3 975 694 A (MELAMED NATHAN T ET AL) 17 August 1976 (1976-08-17) column 1, line 58 -column 2, line 16 -----	14,17, 18,20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02549

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9812583	A	26-03-1998	EP	0927371 A	07-07-1999
EP 0921419	A	09-06-1999	FR	2772141 A	11-06-1999
			JP	11231128 A	27-08-1999
US 4335935	A	22-06-1982	DD	146224 A	28-01-1981
			DE	3014911 A	06-11-1980
			FR	2464486 A	06-03-1981
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US 5850309	A	15-12-1998	JP	9265005 A	07-10-1997
			JP	10160915 A	19-06-1998
US 4519708	A	28-05-1985	AU	572392 B	05-05-1988
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US 4009453	A	22-02-1977	DE	2449312 A	22-04-1976
			BE	834580 A	16-02-1976
			FR	2288319 A	14-05-1976
			GB	1529813 A	25-10-1978
			IT	1043264 B	20-02-1980
			NL	7512111 A	21-04-1976
US 3582815	A	01-06-1971	BE	724872 A	04-06-1969
			BE	725410 A	13-06-1969
			DE	1814039 A	07-08-1969
			FR	1554864 A	24-01-1969
			FR	1594500 A	01-06-1970
			NL	6817061 A	17-06-1969
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US 3975694	A	17-08-1976	NONE		

PATENT COOPERATION TREATY

PCT

REC'D 17 AUG 2001
WIPO PCT

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
00363.IP00.015		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02549	10/07/2000	13/07/1999
International Patent Classification (IPC) or national classification and IPC G02B5/28		
Applicant COHERENT OPTICS EUROPE LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 12 sheets, including this cover sheet.

 ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

 - I ☒ Basis of the report
 - II ☐ Priority
 - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☒ Lack of unity of invention
 - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
 - VI ☐ Certain documents cited
 - VII ☒ Certain defects in the international application
 - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05/02/2001	14.08.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Denise, C Telephone No. +49 89 2399 2452

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02549

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-19 as originally filed

Claims, No.:

1-24 as originally filed

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

 (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

 ☐ the entire international application.

 ☒ claims Nos. 3-6, 15.

because:

 ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

 ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

 ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

 ☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

 ☐ the written form has not been furnished or does not comply with the standard.

 ☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

 ☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1, 2
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1, 2, 7-14, 17, 18, 20-22, 24
Industrial applicability (IA)	Yes:	Claims	1-24
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

SECTION VIII

The following remarks concern lack of clarity (Article 6 PCT) in claims 1, 3, 6-14, 16-23

1 Clarity

1.1 Claim 1
The expression "opaque, reflective layer" is not clear, because "opaque" usually means "which absorbs the radiation for a given wavelength range". In this respect, without knowing precisely the wavelength range for which the optical filter is supposed to work, it is not clear how a metallic layer can, at the same time, be opaque and reflective.

1.2 Claim 3
For the sake of clarity, the following expression in claim 3 "varies in thickness spatially" has been interpreted as "varies substantially in thickness spatially". Without this clarification, because any layer, at least at an atomic level, varies in thickness spatially, it appears that the subject matter of claim 3 is identical to that one of claim 1.

1.3 Claim 6
It appears that an essential feature is missing in claim 6, i.e. the feature responsible for the tunability (in other words, the feature which would allow a user to tune a radiation over a specific wavelength). In its present form, claim 6 recites the subject matter of claims 1 and 4 or claims 1 and 5 and is therefore redundant.

1.4 Claims 7-12 and 15

1.4.1 The parameter x is not defined in claim 7. By considering that the parameter x can be equal to any integer and because in claim 7 it is not clear how the optical filter is rendered tunable, it follows that the subject matter of claim 7 is identical to that one of claim 1 (when n=0 for example).

1.4.2 In claims 7-12 and claim 15, it is also not clear how the filter is rendered tunable.

1.4.3 Furthermore, claim 7 tries to define the optical thickness of the spacer layer with respect to a quarter-wave (a quarter wavelength presumably). Because no wavelength is defined, it follows that the optical thickness of the spacer layer is unknown. This is also valid for claims 8-11 and 12.
In addition, it appears that the passage of claim 7 from line 11 to line 14 recites only a well known property of an optical resonator comprising a spacer layer (like, for instance, a Fabry Pérot resonator).

1.4.4 Remarks similar to those ones made above concerning claim 7 can also be made for claims 8 (section VIII, points 1.4.1 and 1.4.3) and 9 (section VIII, point 1.4.3).
Furthermore, the three last lines of claim 9 refer rather to a well known effect of optical resonator and have not been considered as reciting a limiting feature of the defined optical filter.

1.4.5 Although claims 10, 11 and 12 are drafted as independent claim, it appears that they actually depend on claim 1, because the first layer coming right after M (on the right) can always be considered as being a spacer layer. This renders the scope for which protection is sough unclear.
In addition, it is not clear in claim 12 wether x has a value between 4 and 1000 or a value equal to 100.

1.4.6 Claims 16, 19 and 23
These claims are not allowable under Rule 6.2 (a) PCT (see also the PCT Gazette, section IV, III.4.10)

1.4.7 Claims 14, 17, 18, 20, 21 and 22
It seems that these claims fail to recite all the essential features of the object for which protection is sough. In particular, claims 14, 17, 18, 20 and 21 all recite an induced absorption filter, without indicating the structural features of such a filter.
Either such a filter is not obvious for a skilled person, which, in this case,

means that claims 14, 17, 18, 20 and 21 are obscure. Either such a filter is well known (which appears to be the case, see D3), which, in this case, means that the subject matter of said claims is not novel or does not involve an inventive step (see section V).

Furthermore, claim 22 is obscure because it refers to a fixed or variable wavelength Induced Absorption Filter as claimed in any preceding claims, but it is not clear to which claims it refers.

1.4.8 In addition, it appears that claims 3-6 and 15 are not supported by the description.
Indeed, the description (see page 15, lines 8-11) refers to Patent Applications. The description does not actually describe the technology involved, and therefore does not fulfill the requirements of Article 5 PCT.

1.5 In the description, the distinction between "Rule 1 and Rule 2" (see pages 8 and 9 and "specific embodiments" (see page 16) is not understood.

SECTION III

In the light of the objection made section VIII, point 1.4.8, an examination of claims 3-6 and 15 pursuant to Articles 33 (2) and 33 (3) PCT could not be carried out.

SECTION IV

It appears that, in the light of the remarks made at section VIII, the common concept between claims 1, 15 and 24 is a well known optical filter having an absorbent layer or substrate (see for example D2, abstract and Fig.5).

It follows that there is a lack of unity (Rule 13.1 PCT) between claims 1, 15 and 24.

SECTION V

1 Reference is made to the following documents :

D1 : US-A-4 335 935 (POHLACK HUBERT) 22 June 1982 (1982-06-22)
D2 : EP-A-0 921 419 (COMMISSARIAT ENERGIE ATOMIQUE) 9 June 1999 (1999-06-09) cited in the application
D3 : LEEB W R: 'CO2 Laser Line Selection with Metal Film Reflector' ARCHIV FÜR ELEKTRONIK UND ÜBERTRAGUNGSTECHNIK, vol. 32, no. 5/6, 30 June 1978 (1978-06-30), pages 186-190, XP000960847

2 In the light of what has already been discussed in section VIII, the following remarks concerning lack of novelty (Article 33 (2) PCT) in claims 1, 2 and lack of inventive step in claims 1-2, 7-14, 17-18, 20-22 and 24 (Article 33 (3) PCT) are to be made.

2.1 D1 discloses an absorption device (which can be considered as an optical filter because it can be rendered absorbent in a given spectral range) comprising :

- a dielectric stack of alternating high and low refractive index layers,
- a dielectric spacer layer in juxtaposition with
- an opaque, reflective metallic layer,
- the filter having a resonant wavelength, at which wavelength incident radiation is channelled into, and absorbed by, the metallic layer

See column 3, lines 10-17, wherein the non absorbing layer (3) is considered as a spacer layer, and see in particular lines 16-17 which disclose the functional feature corresponding to the three last lines of claim 1. Furthermore, because the

metallic layer is an absorbing layer (see column 3, line 11), it can be considered as an opaque layer (for the wavelength which are absorbed).

Therefore, D1 discloses an optical filter comprising all the structural and functional features of the optical filter defined in claim 1.

2.2 D2 discloses structures made of a substrate, an absorbing layer and low reflectivity layer (AR) (see column 1, lines 43-44), wherein the absorbing layer can be made of "black chromium" (see column 2, lines 11-12) and the low reflective layer of alternating high and low refractive index layers (see column 2, lines 30-33).
Furthermore, those structures work as "light trap" (see column 1, lines 26-30).
Therefore, it is quite obvious that also for these structures, the filter has a resonant wavelength (due to the alternating dielectric layers) and that the resonant wavelength is absorbed by the metallic absorbing layer (because the purpose of these structures is to reduce as much as possible the reflected light, thus to provide a metallic layer absorbing as much as possible radiation, and in particular the resonant wavelength radiation which contains a lot of energy).

Therefore, D2 discloses also all he structural and functional features recited in claim 1.

In addition, the following can also be said : a skilled person, confronted with the problem of providing a good absorbing filter, would have no difficulty at all, with the teaching of D2, to provide such a filter by an obvious combination of features disclosed in D2, and would arrive at the subject matter of claim 1 without the need of an inventive step.

2.3 Claim 2 : obvious configuration (see D2, Fig.1 and see point 2.1).

Claims 7 and 8 : if n=0, the subject matter of claims 7 and 8 concern only an arbitrary example of optical filter having a substrate, a metallic layer and alternating high and low refractive index layers. The choice of the number of such layers is not considered to be inventive, because no specific effect is expected

from it.

Claim 9 : In the light of the discussion made at section VIII, it appears that the subject matter of claim 9 is also anticipated by documents D1 and D2. A similar conclusion can be drawn about claims 10 and 12.

Claim 11 : The choice of a spacer layer being formed of three high refractive index layers is not considered to involve an inventive step, because it does not bring any specific effect.

Claim 13 concerns only an obvious functional feature, i.e. the optimisation of the profile of a filter curve.

Claim 14 : (see also section VIII). Such a filter (an IAF) is well known in the prior art (see D3).

Claims 17, 20 and 22 : see D3, wherein a IAF is used in a laser (see abstract).

Claims 18 and 21 : the use of two IAF in a laser is only the addition of two non inventive device and is also not considered to involve an inventive step.

Claim 24 : recites only an obvious specific use of a IAF in a laser.

SECTION VII

1 The application does not meet the requirements of **Rule 5.1. (a) (ii) PCT** (citation of relevant prior art documents e.g. D1, D2 and D3).

2 The application does not meet the requirements of **Rule 6.3 (b) (i) and (ii) PCT** (two part form of the independent claim(s)).

3 The application does not meet the requirements of **Rule 6.2 (b) PCT** (reference

numerals in all the claims).

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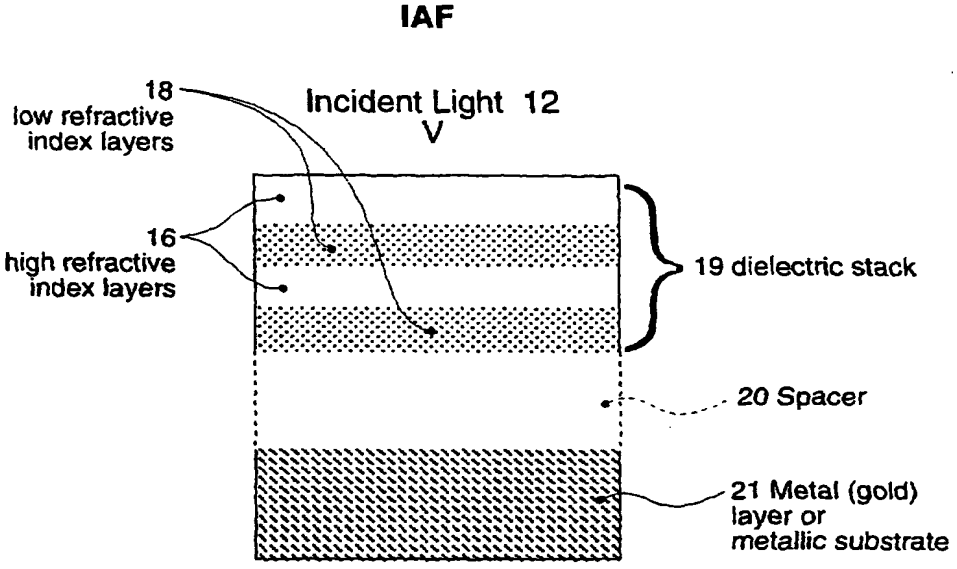
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(54) Title: INDUCED ABSORPTION FILTER (IAF)



(57) Abstract: An optical filter uses a multi-layer, stack of alternating dielectric layers (16, 18) of different refractive indices, a dielectric spacer layer (20) and metal layer (21), to achieve a narrow overall absorption bandwidth, with high reflectance upon either side. A tunable (optical) filter variant uses a dielectric stack and spacer coating of spatially-varying thickness, that is a coating of depth varying, say linearly and/or circularly, according to position across an absorbent layer or substrate, whereby, at different positions on the surface, a different wavelength is absorbed. A tunable laser (35) uses opposed tunable filters (26, 28) bounding a lasing medium (38), such as CO_2 gas, for selective variable stimulated emission of radiation (39).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

'Induced Absorption Filter (IAF)'

This invention relates to optical interference filters, their adaptation to tunable filters and their deployment in lasers - in particular, but not exclusively, tunable lasers, or those which 'lase' at several (discrete) wavelengths.

An aspect of the invention is concerned with a selective, narrow-band (width), absorption filter.

Another aspect of the invention is concerned with a monolithic, continuously variable (wavelength) filter.

Yet another aspect of the invention is concerned with a laser deploying the subject filters, bounding an excitation medium.

A still further aspect of the invention is concerned with a tunable, or 'multiple-line', laser - configured to engender dedicated excitation, at a selectable one or more particular wavelengths.

The various aspects are generally applicable to a range of wavelengths, but on occasion particular emphasis is given to certain regions of the spectrum.

Terminology

Reference is made - in relation to optical properties of materials, and in particular successive layers of material, at certain wavelengths - to the terms refractive index, absorption or extinction (coefficient) and attendant qualifiers (relatively) high and low.

Generally, refractive index (RI) determines the proportion of light reflected at a boundary or interface with another material (medium), of different refractive index.

Thus, for example, at an interface between air (RI unity) and, say, germanium (RI of 4) some 36% of incident light is reflected.

In the present case, where relatively high and low RI materials are juxtaposed, the key factor is the RI differential.

Typically, a high refractive index material would be selected from the RI range 2 to 4, whereas a low refractive index material would be in the range 1.3 to 2.4.

Maximising RI differential allows optical coatings with fewer layers, subject to considerations of intrinsic stresses, transparency and mutual compatibility.

A high reflectivity can be considered as generally better than some 90%.

The other key property of extinction coefficient, or absorptance, concerns how much of incident light traversing an interface is absorbed, per unit length or thickness.

At an atomic level, the absorption mechanism involves an interaction between photons and atoms capable of being excited thereby - which depletes photon energy until exhausted.

Metals typically exhibit high extinction coefficients. Thus for gold, the value is 2, in the visible spectrum region, and 55 in the infra-red region, of some 10.6 microns.

If the extinction coefficient is low, a layer needs to be sufficiently thick to absorb all the light channelled into it.

Thus, absorption, by or through a layer, is determined by a combination of extinction coefficient and layer thickness factors.

Generally, the present case is concerned with extinction coefficients in the range 2 to 60, with a typical layer thickness of some 100nm.

Interference Filters

Many types of interference filter are known - including long wave-pass, short wave-pass, and band-pass filters, dielectric enhanced metallic reflectors, induced transmission filters and broad-band absorption filters.

An instance is a narrow-band, absorption filter. This absorbs, (or attenuates) strongly at a discrete wavelength, whilst being non-dissipative (eg highly reflective) in spectral regions both immediately above and below this wavelength.

Many such filter types are described in, for instance, 'Thin-Film Optical Filters', by H A Macleod, (2nd edition, published by Adam Hilger).

Broad-band absorption filter types are described in EP 0921 419 A1 'Revetment absorbeur de lumiere a haut pouvoir absorbant', of inventors Quesnel and Chaton.

Prefacing Statement of Invention

The present invention addresses a new class of thin-film, interference filter construction, which effects narrow-band absorption.

Versions of such a filter are useful in 'tuning' laser excitation and radiation, such as in a carbon dioxide (CO_2) lasing medium.

Background Art - Dielectric Filters

A simple (dielectric) band-pass filter consists of two dielectric 'stacks' - acting as (reflector) mirrors - disposed at opposite sides of a dielectric 'spacer' layer.

Resonance is set up, or engendered, (in the spacer layer) between such opposed (dielectric stack) reflectors.

This resonance causes, or allows, transmission of light, at a particular wavelength - in practice equal to half the optical thickness of the spacer layer.

A high level of reflectance (ie non-transmission) is achieved at both sides of a (transmission) pass-band.

Fabry-Perot Filter

One well-known type of (dielectric, interference) filter is the so-called Fabry-Perot filter.

The principles of the Fabry-Perot filter are described, for example, in the references:

'Thin Film Optical Filters', by H.A.Macleod, 2nd edition, published by Adam Hilger, pp238 to 257; and

The Optical Society of America's 'Handbook of Optics', published by McGraw Hill, pp8-76 to 8-80.

Fabry-Perot filters are based upon an interferometer of the same name, employing two identical reflecting surfaces, spaced apart by a set distance.

A Fabry-Perot filter contains the same essential components - namely two reflectors and a spacer.

The reflectors can either be metallic layers, or dielectric stacks.

Essentially, such a dielectric (reflector) stack is a (sequential) multi-layer, or tiered, structure - of alternating layers of differing refractive indices.

This stack acts like a partially or highly reflective mirror and has essentially no absorbing component.

It is important that the intervening spacer layer is a non-absorbing material.

Generally, a Fabry-Perot filter has three basic components, positioned in a particular relative disposition, or sequence, as follows:

- a 'partially or highly reflective' mirror,
- a non-absorbing, dielectric 'spacer' layer, and,
- a second, 'partially or highly reflective', mirror.

Light is typically incident upon a first mirror in this sequence.

Both partially or highly reflective mirrors typically have a near-unity reflectance factor (for certain reflected wavelengths).

In the particular case of a 'thin-film' Fabry-Perot filter, the two mirrors each commonly comprise (sequentially-stacked) tiered dielectric layers - of alternating (relatively) low and high refractive indices.

Here, again the reflectance factor of each thin-film mirror stack is close to unity, for certain wavelengths.

A Fabry-Perot filter has a resonance at a wavelength equal to one half of the optical thickness of the spacer layer.

Thus the thickness of the spacer layer is typically a 'half-wave' optical thickness.

In a thin-film Fabry-Perot filter, with all-dielectric layers, a very narrow wavelength band - centered at the resonant wavelength - is transmitted through the filter.

Incident light, at broad wavelength regions, on both sides of this narrow wavelength band, is highly reflected (again, a near-unity reflectance factor).

Although not generally accepted thin-film filter terminology, a thin-film, Fabry-Perot filter could be categorised as an Induced Transmission Filter (ITF).

Statement of Invention
Induced Absorption Filter (IAF)

In certain respects, an Induced Absorption Filter (IAF), according to one aspect of the present invention, represents both a development of - and significant departure from - a Fabry-Perot filter, or ITF.

More specifically, in an IAF according to the invention, a second dielectric mirror stack of the ITF configuration is replaced by a highly reflective, opaque, metal layer.

The high extinction coefficient of this second mirror engenders narrow-band absorption rather than narrow- band transmission - thus representing a significant distinction from, and differentiation over, an ITF.

Retention of a spacer layer, preserves the three component configuration of a Fabry-Perot Filter, or ITF - and therefore its resonance.

However, a significant distinction over an ITF arises, since:

- a narrow wavelength band, centered at the resonant wavelength, is essentially not reflected (near-zero reflectance factor), and
- the second mirror is opaque.

Thus, this narrow wavelength band is highly absorbed (by a factor of near-unity), in an IAF according to the invention.

Essentially, a filter according to the invention induces narrow-band absorption - hence the designation Induced Absorption Filter (IAF) - whilst highly reflecting (broad) wavelength bands, both above and below the absorbed wavelength band.

IAF General Case Embodiments

Generally, a thin-film IAF, according to the invention, is typically deposited upon a substrate, as the following layer sequence:

- a metal mirror (opaque metallic thin film),
- a dielectric 'spacer' layer, and
- a dielectric mirror stack.

Light is incident upon the dielectric mirror stack.

The metal layer thickness is not critical, provided it exceeds a threshold value, determined by its extinction coefficient.

Alternatively, a highly reflective metal substrate could replace the metal mirror. The substrate essentially provides mechanical support for a (fragile) thin film structure.

In the case of a Fabry Perot filter, a mounting substrate is transparent at the transmitted wavelength. However, for an IAF filter according to the invention - with an intervening metal layer - no light reaches the (mounting) substrate, so transmittance or absorbence is not an issue.

For laser filter applications, the resonant wavelength of the IAF is typically the laser wavelength to be suppressed.

In some cases, there may be a plurality of laser wavelengths to be suppressed.

An IAF according to the invention can accomplish this, based upon the following general rules:

Rule 1

If the dielectric spacer layer is, or comprises, a low refractive index material;

where the dielectric mirror stack comprises:

- the same (or similar) low refractive index material; and
- a (relatively) high refractive index material;

the primary resonant wavelength occurs when the spacer layer is equal to even integer multiples of quarter-waves (optical thickness), including zero (absentee layer).

The corresponding primary resonant wavelength equals the optical thickness of the quarter-wave - independently of the multiple of the selected quarter-wave thickness.

The overall stacking configuration can be described symbolically, as:

Substrate / M nL $(HL)^x$ H /ambient

... where:

M is a metal mirror thin film;

'n' = 0,2,4,6, etc... is an even integer multiple of the quarter wave optical thickness of the spacer layer;

H and L represent quarter wave optical thicknesses, respectively of high and low refractive index layers; and

'x' is a number of pairs of H and L layers required to produce a high reflectance mirror.

Rule 2

If the dielectric spacer layer is, or comprises, a high refractive index material;

where the dielectric mirror stack comprises:

- the same (or similar) high refractive index material; and
- a low refractive index material;

the primary resonant wavelength occurs when the spacer layer is equal to odd integer multiples of quarter-waves (optical thickness), including zero.

The corresponding primary resonant wavelength equals the optical thickness of the quarter-wave - independently of the multiple of the selected quarter-wave optical thickness.

The overall stacking configuration can be described symbolically, as;

Substrate / M nH $(LH)^x$ /ambient

n = 0,1,3,5,7,...

Rule 3

For both cases, whether the spacer layer is of either high or low refractive index, as the integer multiple of the quarter wave optical thickness is increased, the secondary resonant wavelengths move closer to the primary resonant wavelength.

The secondary resonant wavelengths are present, regardless of the integer multiple - and also occur for real number multiples in-between the prescribed integer multiples.

The required spacer layer thickness for the desired spacing of the resonant wavelengths can be directly calculated, based upon formulae for Fabry-Perot filters from standard thin-film texts.

Illustrated Example of Fabry-Perot Filter

A typical (all) dielectric Fabry-Perot filter construction is depicted in Figure 1 of the drawings.

A transparent spacer layer 14 is enclosed between two reflecting dielectric stacks 11, 13 - each a multi-layered tier of alternating refractive index materials.

Incident light radiation 12 is transmitted through this configuration 10 - at wavelengths proportional to the thickness of the spacer layer 14 .

Substrate 17, acts as a mechanical support for the thin film structure, and is transparent to transmitted light.

Typical overall filter performance is represented graphically in Figure 2.

Filter aspects of the present invention are concerned with variants of such a stacked array of multiple dielectric layers in juxtaposition.

Statement of Invention

According to one aspect of the invention,
an optical filter comprises
a dielectric stack
of alternating (relatively) high and low refractive index layers,
a dielectric spacer layer,
in juxtaposition with
an opaque, reflective metallic layer or substrate,
the filter having a resonant wavelength
at which wavelength incident radiation is channelled into,
and absorbed by, the metallic layer or substrate.

In other configurations, multiple dielectric stacks and spacers can be used according to conventional bandpass filter design techniques.

The common feature is that the lowermost reflector is metallic in nature, with a high reflectivity and extinction coefficient in the spectral region of operation.

These constructions result in a filter of high average reflectivity (say ≥99%) across a broad operating band, but which is also highly absorbing in a narrow wavelength band within the broader region. The width of the absorption feature is typically as low as 1% in bandwidth, with absorption maxima typically in the 80-99 % range,

Such a construction represents an essentially new type of thin film interference filter, one for which the term 'Induced Absorption Filter' (IAF) has been coined.

In characterising, or differentiating construction of an Induced Absorption Filter according to the invention, over known filter art, one of the dielectric reflector stacks in a conventional (Fabry-Perot type) filter is replaced with a metallic reflector element.

A particular spectral region of operation is from 8 to 12 μm; although by suitable choice of materials the filter can be optimised to operate in any spectral region.

Illustrated Example of Induced Absorption Filter (IAF)

More specifically, referring to Figure 3 of the drawings, a dielectric stack 19, of alternating layers 16, 18 of different refractive index H, L, is disposed upon a transparent dielectric 'spacer' layer 20.

These in turn are disposed upon a metal layer 21, such as gold, with a high reflectivity and extinction coefficient.

The metal layer 21 could be a coating upon a substrate (not shown), or alternatively could be substituted by a metallic substrate (not shown).

The structure appears to incident radiation to be a bandpass filter, in that there are two reflectors, one on each side of a spacer layer.

Due to resonance within the spacer layer, one or more particular wavelengths try to pass though the structure, but these become absorbed within the metallic layer - due to the high extinction coefficient of the metal.

All other incident radiation is reflected with high efficiency. For at these wavelengths the combination of a metal layer and dielectric stack acts as an enhanced reflector.

As stated above a metal substrate could be used instead of a deposited metallic layer. In this case the device could be actively cooled if used in high power applications.

The overall Induced Absorption Filter (IAF) construction, according to one aspect of the invention, is straightforward - and in physical thickness amounts to less than half that of an equivalent Fabry-Perot band-pass filter.

Such an Induced Absorption Filter (IAF) can be fabricated by a graded thickness coating technology (described later), in order to achieve a tunable filter performance.

Firstly though, the application of Induced Absorption Filter technology to a laser, according to another aspect of the invention, will be described.

Laser Application of Induced Absorption Filter (IAF)

In some circumstances, the ability of lasers, such as a carbon dioxide (CO_2) medium laser, to operate at more than one wavelength - with an overall performance as depicted graphically in Figure 4 - can be detrimental.

Thus, in most applications, such as cutting, welding, etching and marking, it is desirable for the properties of the beam to remain constant throughout the operation.

It is not therefore beneficial if the laser 'drifts' - that is skips from one operating wavelength to another, or if it operates at several wavelengths simultaneously.

Most lasers consist of a tube of lasing medium (such as CO_2), contained between two (reflecting) mirrors.

Radiation travelling backwards and forwards between the two mirrors results in light amplification, by stimulated emission of radiation.

Supplementary Statement of Invention - Laser

According to another aspect of the invention
a laser resonator
is terminated by first and second mirrors,
bounding an intervening lasing medium,
which, upon being energised,
can provide (optical) gain,
at first and second wavelengths,
at least one of the mirrors
having sufficient reflectivity at the first wavelength,
that laser radiation is generated by the resonator,
upon excitation of the gain medium,
whilst being sufficiently absorptive,
at the second wavelength,
that laser radiation is not generated by the resonator, upon the same excitation.

The laser will only operate at wavelengths at which the mirrors are highly reflecting (ie reflectively efficient).

If it is desired to constrain the operating wavelength to, for instance 10.6 μm, it is possible, according to another aspect of the invention, to replace the mirrors with Induced Absorption Filters according to one aspect of the invention.

The Induced Absorption Filters prevent, inhibit, or suppress amplification of radiation at either side of a target wavelength.

Thus, in this instance, a filter 26 would be designed to absorb at, for instance, 10.5 μm, at one end of a laser tube 37, and a companion filter 28 at 10.7 μm, at the other - as depicted in Figure 7.

External excitation 36, applied to a lasing medium, in this instance CO_2 gas 38, confined within the tube, promotes a stimulated emission of radiation, or lasing, resonance.

Such radiation is allowed to exit at one end of the confinement tube 37, through a window 34 in the filter mirror 26.

Alternatively, if it is desired to use only one mirror, in order to constrain operation of the laser to one wavelength, an induced absorption 'comb' filter could be used - with an overall performance characteristic as depicted graphically in Figure 8.

Laser Tuning - for Cutting/Machining or Welding

Carbon dioxide (CO_2) lasers are often used to cut, machine or weld common fabrication materials, such as metals, wood and plastics.

Many materials, including most plastics, have a series of discrete absorption bands in the infrared.

By adoption of IAF technology of the present invention, a laser could be 'tuned' to operate at a wavelength corresponding to that of an absorption band of the material being cut.

Thus, rather than much of the energy being transmitted through the plastic, it would mostly be absorbed and so contribute to an energy transfer to the material.

The (cutting, machining or welding) operation would then become more efficient.

Thus a tuned laser would be able to cut or melt the material much more quickly.

Alternatively, a smaller, less expensive, laser than that of a conventional laser employed hitherto, could be used for the task.

A simple IAF filter device could be used actively to tune carbon dioxide lasers.

Laser Marking

Lasers are often used to apply identification marks, or decorative pattern, for materials such as plastics, woods or metals.

Improved edge definition - and therefore, a sharper image - is obtained with monochromatic laser radiation, achievable with an IAF tuned laser according to the present invention.

3D Filter Coating

The Applicants have developed a thin film, three-dimensional (3D) variable coating technology - the subject of their pending UK Patent Application 9722295.4, and corresponding US Patent Application 08/891,750 and US CIP Application No: 09/233903.

This enables controlled (coating) thickness, or depth, grading of optical thin films, in relation to spatial position, upon a substrate.

In an Induced Absorption Filter according to one aspect of the invention, the wavelength at which radiation is absorbed is dependent only upon the thickness of the dielectric *spacer* layer.

Taken in conjunction with the Applicants' aforementioned variable coating thickness technique, a variable *wavelength absorption* filter is achievable.

Supplementary Statement of Invention
- Variable Filter

According to yet another aspect of the invention,
dielectric layers/stack and/or the spacer are graded (or progressively varied)
say, circularly and/or linearly,
in thickness,
over the surface of a filter,
whereby,

at different positions on the surface,
a different wavelength is absorbed.

Thus, by rotating, or translating, circular or linear variable wavelength induced absorbing filters relative to incident light, beam tuning is achieved.

With a filter position/orientation control mechanism, such variable coating filters could be operated co-operatively in tandem, in order to constrain light amplification at any wavelength at which a laser is capable of operating.

Known Art Relating to the Use of Diffraction Gratings in the Tuning of Laser Radiation

In effect, the filters form an (relatively inexpensive) alternative to the diffraction grating (and associated mechanisms), commonly used to perform a tuning function, as exemplified by, say, the references:

- 'An independently controllable multi-line laser resonator and its use in multi-frequency injection locking', by R.L.Sheffield, S.Nazemi and A.Javan, Advanced Physics Letters 29, pp 588 to 590; and

- 'A compact, simple stepping motor controlled laser grating mount', by T.W.Carmen, P.E.Dyer and P.Monk, J. Phys E. 13).

Whilst carbon dioxide lasers have been referred to in the illustrative example above, the tunable filter technique according to the invention could be applied to other areas of the (optical) spectrum, such as the visible, near, or medium wave infrared.

Specific Embodiments

There now follows a description of some particular embodiments of the invention, by way of example only, with reference, on occasion, to the accompanying diagrammatic and schematic drawings.

A dielectric stack filter coating utilises sequentially-tiered, paired layers 16, 18 of (relatively) high H (or medium M) and low L refractive index materials, their optical

thickness being related to the intended operating wavelength.

Such 'index-pairs' (H-L) could consist of zinc sulphide or selenide, in combination with either thorium fluoride, or germanium.

The layers are deposited alternately.

Beneath the dielectric stack is a dielectric spacer layer, typically but not necessarily comprising one of the two materials used within the stack.

The quarter-wave optical thickness of this layer is close to, but not necessarily exactly equal to, a multiple (see 'Rules') of the wavelength at which absorption is desired.

In the examples below, the material pair used is:

- zinc sulphide - of quarter-wave optical thickness 'H'; and
- thorium fluoride - of quarter-wave optical thickness 'L'.

As with band-pass filters, there is an almost unlimited variety of constructions that could be used.

The design examples shown below are relatively straightforward, and use gold (Au) as a metal M layer.

Example 1:

Substrate / M H $(LH)^4$ / ambient

... where H and L equal one quarter-wave optical thicknesses, of relatively high and low refractive index materials, respectively.

Example 2:

Substrate / M HHH $(LH)^4$ / ambient

... where H and L equal one quarter-wave optical thicknesses, of relatively high and low refractive index materials, respectively.

Calculated spectral performances of Examples 1 and 2 are depicted in Figure 5.

Actual performance of Example 1 is shown in Figure 6.

Those skilled in the art will recognise that additional dielectric spacers (not shown) could be incorporated, in order to steepen the absorption edge (or sharpen the transition between absorption and reflection) - and so 'square off' the performance of the filters.

Yet another aspect of the invention provides an Induced Absorption Comb Filter, of configuration:

Example 3:

Substrate / M $(HL)^2$ x$H(LH)^2$ / ambient

... where H and L equal one quarter-wave optical thickness, of relatively high and low refractive index materials, respectively.

and x = lies generally in the range of about 4 through 1000; for example x = 100.

The performance of this filter (where x =100) is depicted in Figure 8.

Component List

10	filter configuration
11	dielectric stack (Fabry-Perot filter)
12	incident light
13	dielectric stack (Fabry-Perot filter)
14	dielectric spacer (Fabry-Perot filter)
16	high (H) refractive index material
17	substrate (Fabry-Perot filter)
18	low (L) refractive index material
19	dielectric stack (IAF)
20	dielectric (transparent) spacer layer (IAF)
21	metal layer (IAF)
26	filter/mirror
28	filter/mirror
34	window
35	tunable laser
36	excitation
37	laser confinement tube
38	lasing medium (eg CO_2 gas)
39	LASER beam

Claims

1.

An (optical) filter comprising
a dielectric stack
of alternating (relatively) high and low refractive index layers,
a dielectric spacer layer,
in juxtaposition with
an opaque, reflective metallic layer or substrate,
the filter having a resonant wavelength,
at which wavelength incident radiation is channelled into,
and absorbed by, the metallic layer or substrate.

2.

An (optical) filter,
as claimed in Claim 1,
in which unique case the dielectric spacer layer
has the same composition and thickness
as one of the constituent layers in the dielectric stack,
and wherein it therefore appears that the stack is in direct juxtaposition
with the metallic layer or substrate.

3. {spatially-variable depth}

An (optical) filter, as claimed in Claim 1 or 2,
wherein the dielectric stack and/or spacer,
varies in thickness spatially,
over the metallic layer or substrate.

4. {circular variability}

An (optical) filter, as claimed in any of the preceding claims, wherein the dielectric stack, and/or spacer, thickness varies circularly over the metallic layer or substrate.

5. {linear variability}

An (optical) filter, as claimed in any of the preceding claims, wherein the dielectric stack, and/or spacer, thickness varies linearly over the metallic layer or substrate.

6. {tunability}

A monolithic, selectively variable, or tunable-wavelength, narrow-band, absorption (optical) filter, comprising a dielectric stack, and/or spacer, of spatially varying-thickness, deposited upon an absorbent and reflective metallic layer, or substrate, the wavelength absorbed varying with (linear and/or rotational) position of (the stack and/or spacer) filter, in relation to incident light.

7. {stacking sequence - Rule 1}

A single, or multiple wavelength (tunable),
(optical) filter,
including a metallic layer, separated,
by a dielectric spacer layer,
of a low refractive index material,
from a dielectric mirror stack,
comprising alternating layers, respectively of
the same (or similar) low refractive index material,
and a relatively high refractive index material;
a primary resonant wavelength occurring
when the spacer layer is equal to
even integer multiples
of a quarter-wave (optical thickness),
including zero (absentee layer),
and symbolically described as;

Substrate / M nL $(HL)^x$ H /ambient

... where:

M is the metal mirror thin film;

n = 0,2,4,6, etc... ; even integer multiples of the quarter wave optical thickness of the spacer layer; and

H and L represent quarter wave optical thicknesses respectively of the high and low refractive index layers.

8. {stacking sequence - Rule 2}

A single, or multiple wavelength (tunable)
(optical) filter,
including a metallic layer, separated by
a dielectric spacer layer,
of a high refractive index material, from
a dielectric mirror stack,
comprising alternating layers, respectively of
the same (or similar) high refractive index material;
and a relatively low refractive index material;
a primary resonant wavelength occurring
when the spacer layer is equal to
odd integer multiples of quarter-wave (optical thickness),
symbolically described as;

Substrate / M nH $(LH)^x$ / ambient

... where:

M is the metal mirror thin film;

n = 0,1,3,5,7,..., odd integer multiples of the quarter wave optical thickness of the spacer layer; and

H and L represent quarter wave optical thicknesses respectively of the high and low refractive index layers.

9. {stacking sequence - Rule 3}

A single, or multiple wavelength (tunable)
(optical) filter,
including a metallic layer, separated,
by a dielectric spacer layer,
of either high or low refractive index material, from
a dielectric mirror stack,
comprising alternating layers, respectively of
relatively high and low refractive index material;
the spacer layer thickness being
integer multiples of quarter-waves (optical thickness),
and, as this multiple increases,
secondary resonant wavelengths move closer
to the primary resonant wavelength.

10. {stacking sequence}

A single, or multiple wavelength (tunable)
(optical) filter,
with a dielectric reflector comprising
a tiered multi-layer stacking sequence of:

Substrate / M H $(LH)^4$ / ambient

... where H and L equal one quarter-wave optical thicknesses, of relatively high and low refractive index materials, respectively, zinc sulphide and thorium flouride.

11. {alternative stacking sequence}

A single, or multiple (tunable) wavelength (optical) filter,
with a dielectric reflector comprising
a tiered multi-layer stacking sequence of:

Substrate / M HHH $(LH)^4$ / ambient

... where H and L equal one quarter-wave optical thicknesses, of relatively high and low refractive index materials, respectively, zinc sulphide and thorium flouride.

12. {further stacking sequence}

A single, or multiple (tunable) wavelength (optical) filter,
with a dielectric reflector comprising
a tiered multi-layer stacking sequence of:

Substrate / M $(HL)^2$ x$H(LH)^2$ / ambient

... where H and L equal one quarter-wave optical thickness, of relatively high and low refractive index materials, respectively, zinc sulphide and thorium flouride;

'x' is between about 4 through 1000;
for example x = 100.

13. {squared-off performance}

An (optical) filter, as claimed in any of the preceding claims,
incorporating additional dielectric spacers,
configured to steepen the absorption characteristic edge
and so 'square off' filter performance;

14.

An induced absorption (optical) filter,
configured to operate
in the wavelength band 8 to 12μm.

15.

A tunable absorption (optical) filter,
with a spatially varying reflector coating depth,
upon an absorbent layer or substrate,
and configured to operate
in the wavelength band 8 to 12μm.

16.

A tunable (optical) filter,
substantially as hereinbefore described,
with reference to, and as shown in,
the accompanying drawings.

17.

A laser,
incorporating an Induced Absorption Filter (IAF),
at one end of a resonator.

18.

A laser,
incorporating an Induced Absorption Filter (IAF),
at each end of a resonator.

19.

A laser,
substantially as hereinbefore described,
with reference to, and as shown in,
the accompanying drawings.

20.

A tunable or multi-line laser,
incorporating an Induced Absorption Filter (IAF),
at one end of a resonator,
and configured to operate
in the waveband 8 to 12 μm.

21.

A tunable or multi-line laser,
incorporating an Induced Absorption Filter (IAF),
at each end of a resonator,
bounding a lasing medium,
and configured to operate
in the waveband 8 to 12 μm.

22.

A tunable, or multi-line, laser
incorporating a fixed, or variable,
wavelength Induced Absorption Filter (IAF),
as claimed in any of the preceding claims.

23.

A tunable, or multi-line, laser
substantially as hereinbefore described,
with reference to, and as shown in,
the accompanying drawings.

24. {laser resonator}

A laser resonator,
terminated by first and second mirrors,
bounding an intervening lasing medium,
which, upon being energised,
can provide (optical) gain,
at first and second wavelengths;
at least one of the mirrors
having sufficient reflectivity, at the first wavelength,
that laser radiation is generated,
by the resonator,
upon excitation of the gain medium,
whilst being sufficiently absorptive,
at the second wavelength,
that laser radiation is not generated
by the resonator,
upon the same excitation.

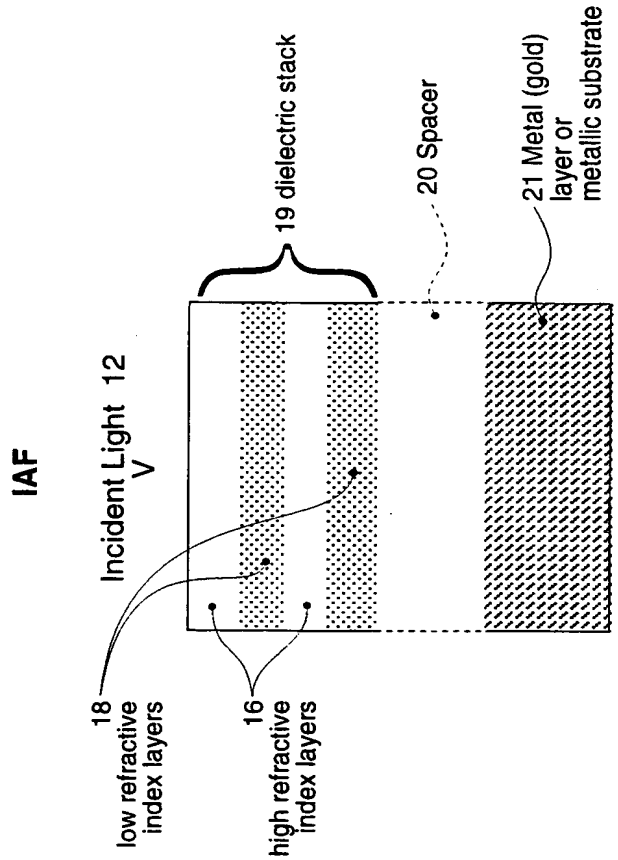


Figure 3

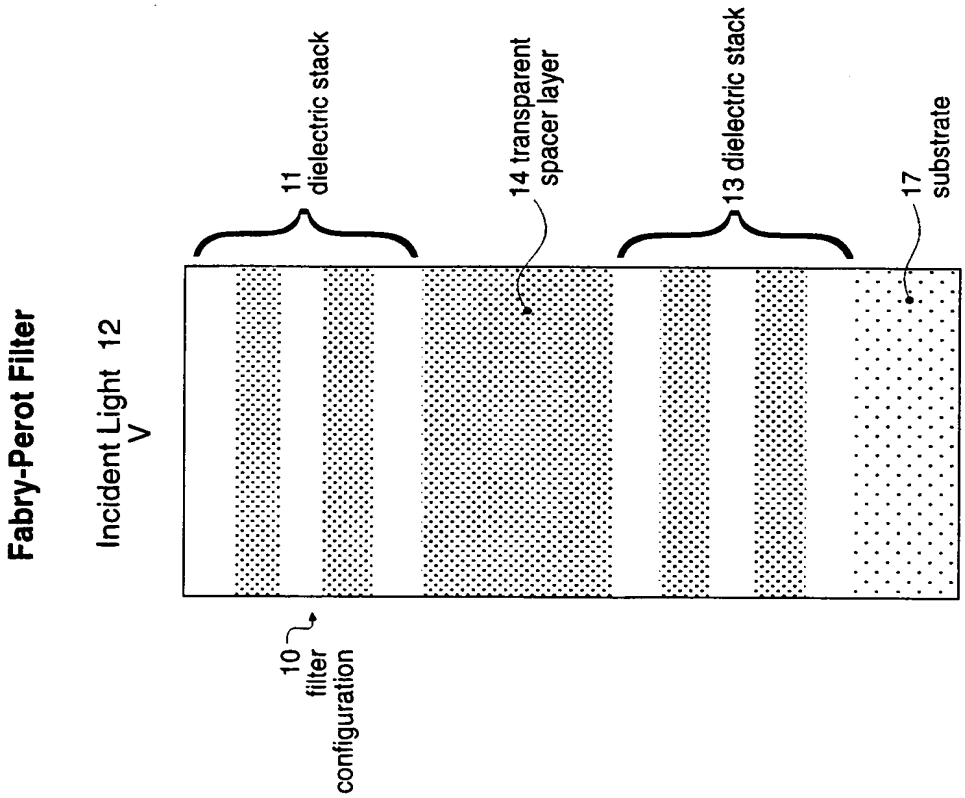


Figure 1

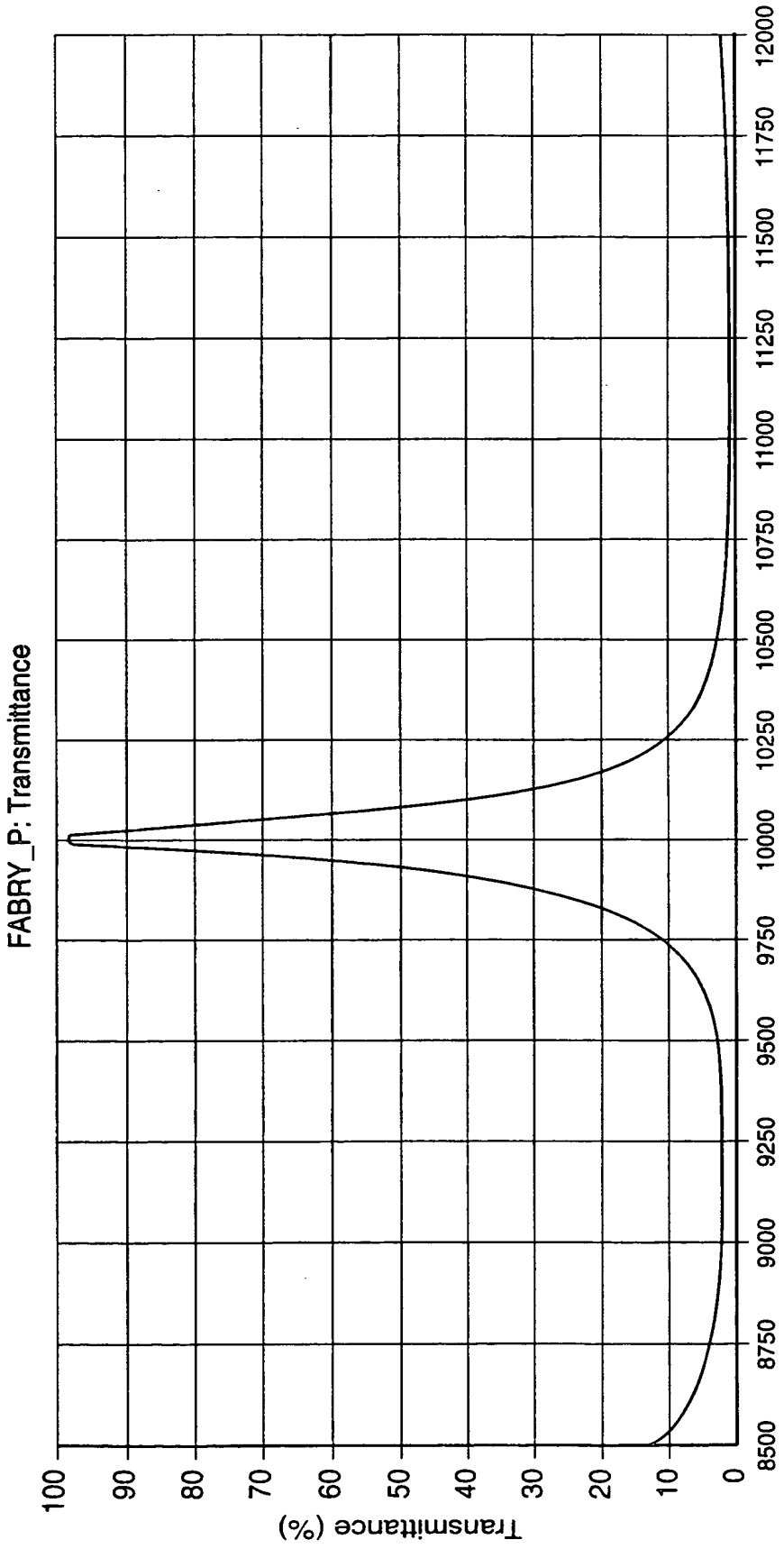

FABRY_P: Transmittance
Transmittance (%)
100
90
80
70
60
50
40
30
20
10
0
8500
8750
9000
9250
9500
9750
10000
10250
10500
10750
11000
11250
11500
11750
12000
Wavelength (nm)

Figure 2

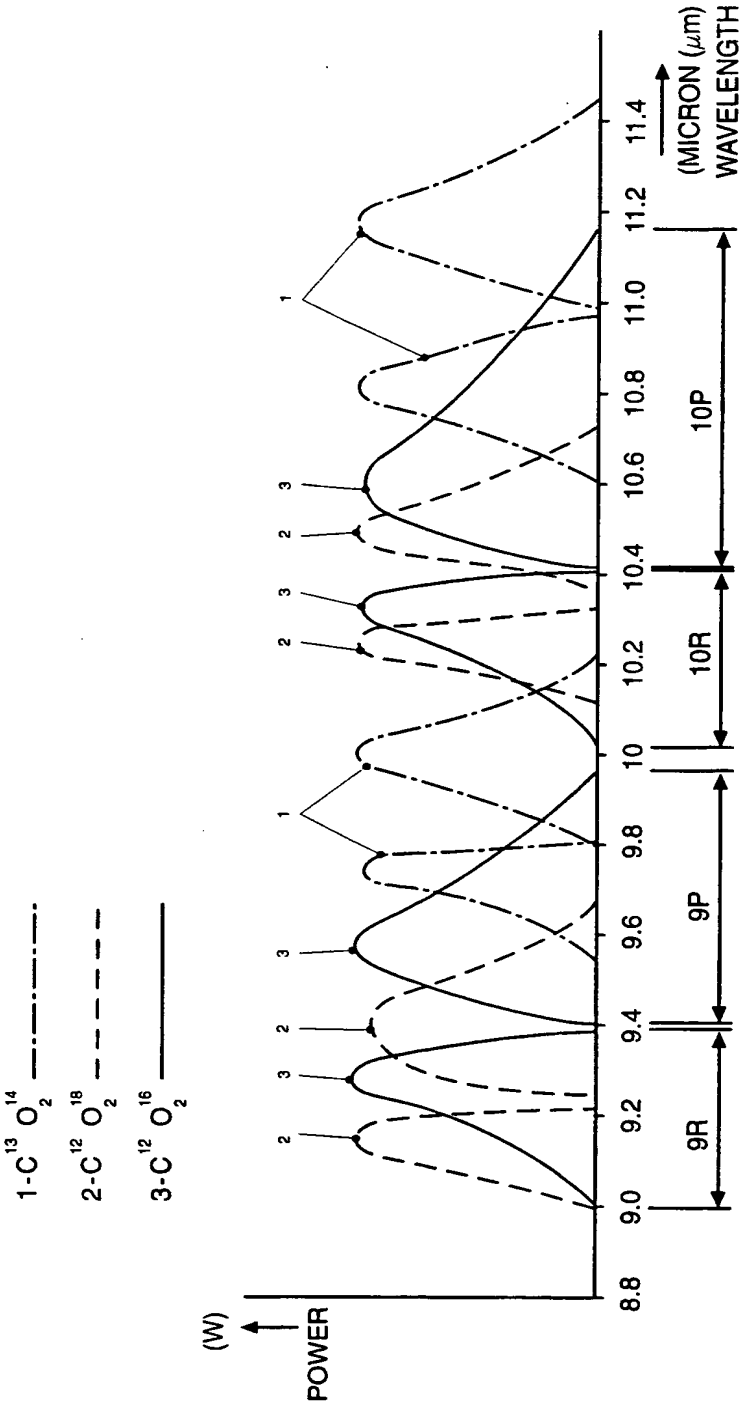

1-C13 O2
2-C12 O2
3-C12 O2
POWER
(W)
8.8
9.0
9.2
9.4
9.6
9.8
10
10.2
10.4
10.6
10.8
11.0
11.2
11.4
(MICRON (μm)
WAVELENGTH
9R
9P
10R
10P

Figure 4

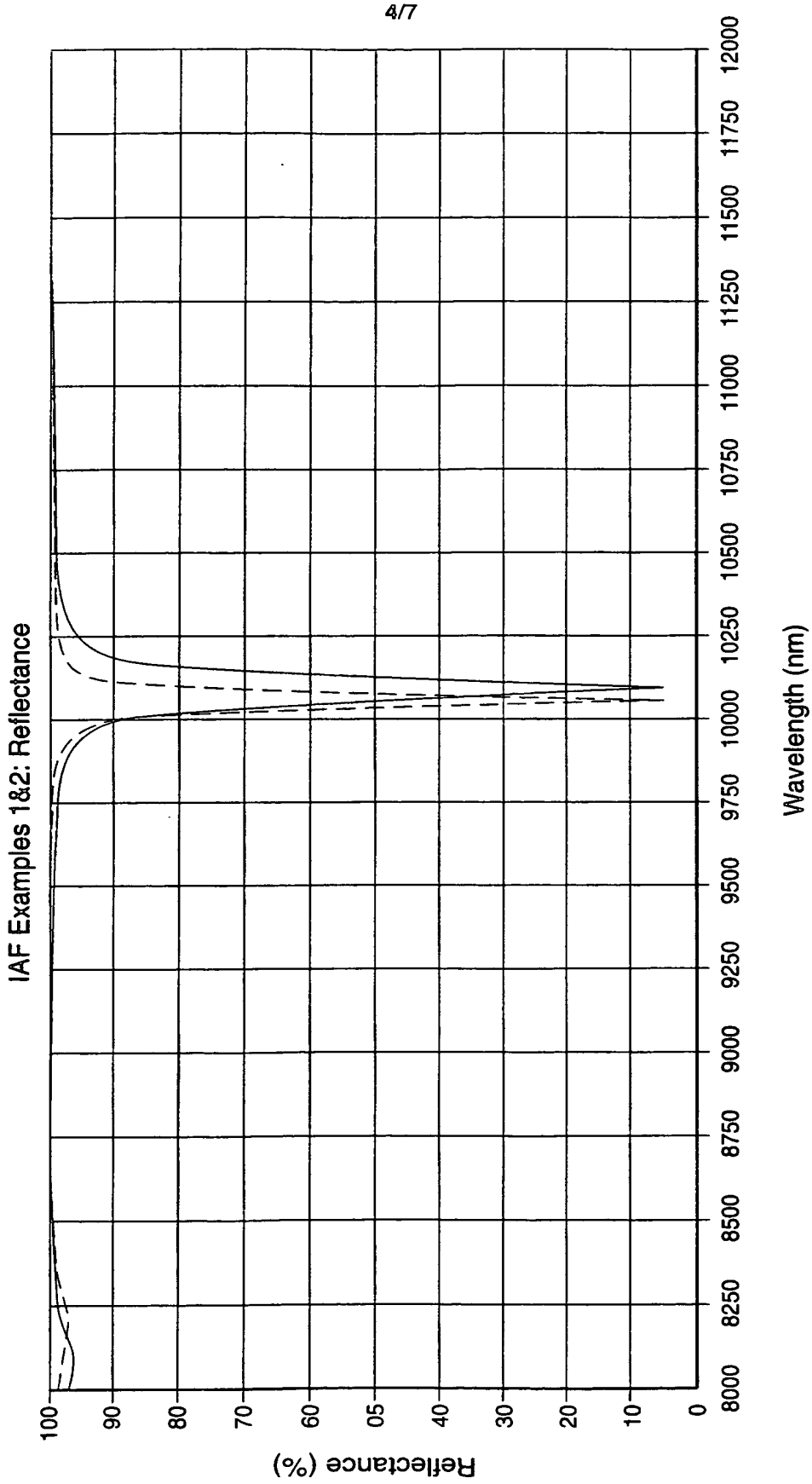

IAF Examples 1&2: Reflectance
Reflectance (%)
100
90
80
70
60
05
40
30
20
10
0
8000
8250
8500
8750
9000
9250
9500
9750
10000
10250
10500
10750
11000
11250
11500
11750
12000
Wavelength (nm)

Figure 5

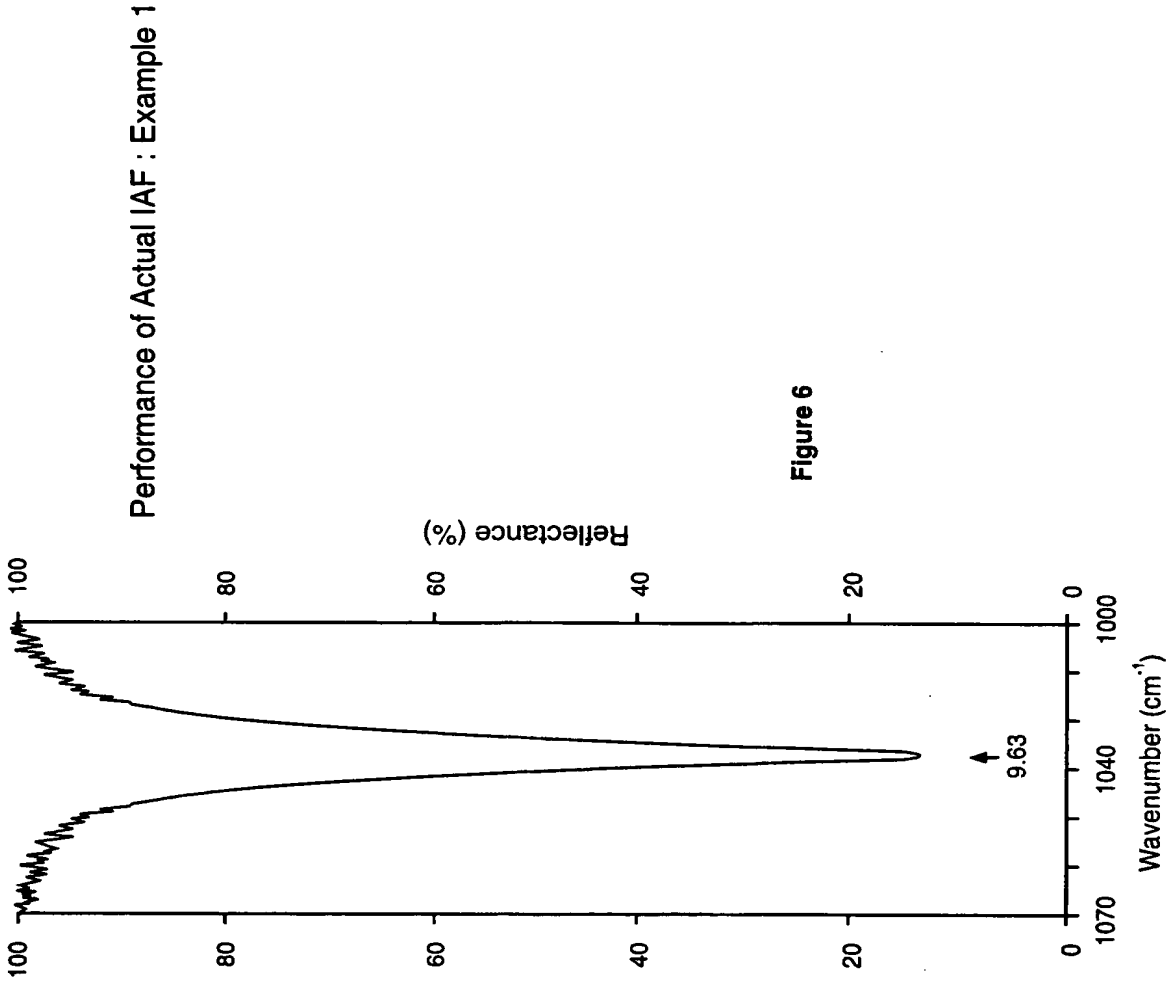

Performance of Actual IAF : Example 1
Reflectance (%)
100
80
60
40
20
0
1000
1040
1070
Wavenumber (cm-1)
9.63

Figure 6

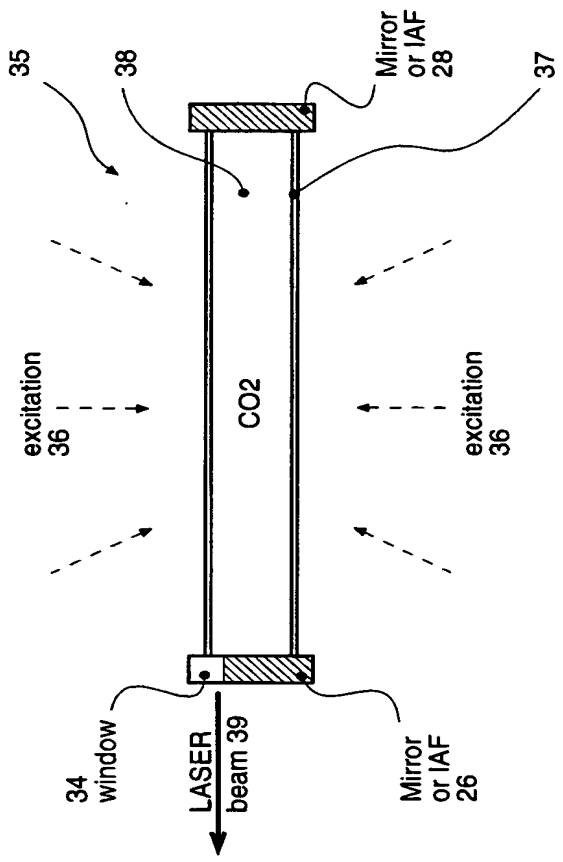

35
38
Mirror or IAF 28
37
excitation 36
CO2
excitation 36
34 window
LASER beam 39
Mirror or IAF 26

Figure 7

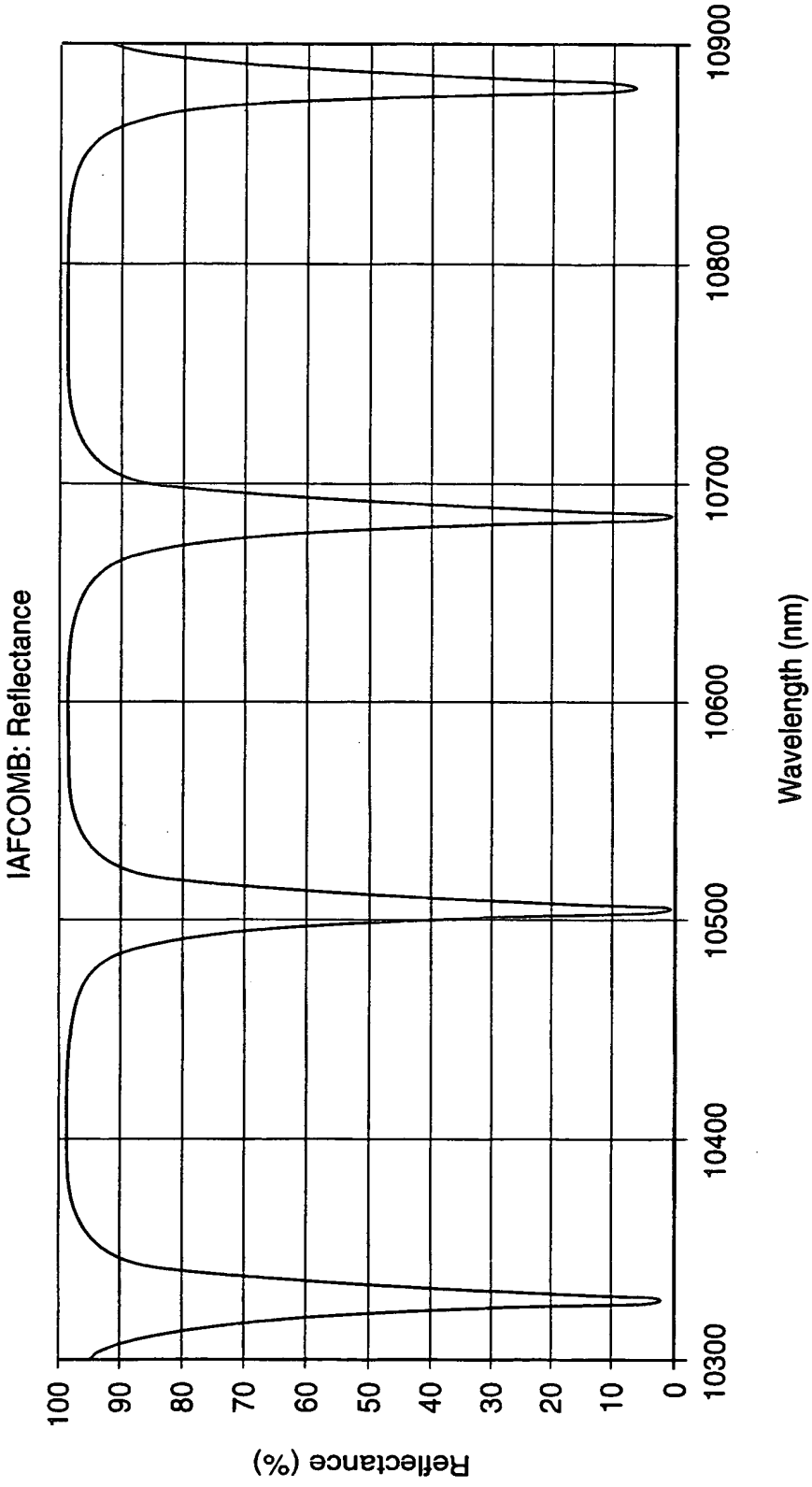

IAFCOMB: Reflectance
Reflectance (%)
100
90
80
70
60
50
40
30
20
10
0
10300
10400
10500
10600
10700
10800
10900
Wavelength (nm)

Figure 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02549

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B5/28 G02B5/08 H01S3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02B H01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LEEB W R: "CO2 Laser Line Selection with Metal Film Reflector" ARCHIV FÜR ELEKTRONIK UND ÜBERTRAGUNGSTECHNIK, vol. 32, no. 5/6, 30 June 1978 (1978-06-30), pages 186-190, XP000960847 the whole document	14,17, 18,20, 21,24
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Y	page 3 -page 4, paragraph 1 page 12, paragraph 4 -page 13, paragraph 1	3-6,13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2000	08/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mollenhauer, R

3

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Y	GB 2 321 256 A (COHERENT OPTICS) 22 July 1998 (1998-07-22) cited in the application the whole document	3-6

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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...ormation on patent family members

Inter...al Application No
PCT/GB 00/02549

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